

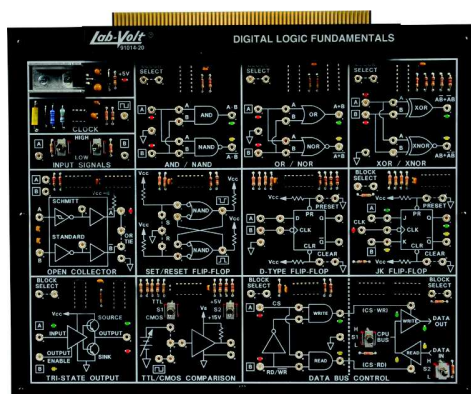
Exercise 1: Circuit Block Familiarization

EXERCISE OBJECTIVE

When you have completed this exercise, you will be able to locate and identify the circuit blocks and components on the DIGITAL LOGIC FUNDAMENTALS circuit board. You will verify your results by identifying logic circuits and making logic level measurements with a voltmeter and an oscilloscope.

EXERCISE DISCUSSION

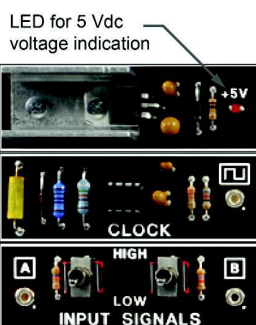
The DIGITAL LOGIC FUNDAMENTALS circuit board provides examples of logic circuits.



There are thirteen circuit blocks on the DIGITAL LOGIC FUNDAMENTALS circuit board connected to your base unit.

Examine these circuit blocks.

Three of the circuit blocks are support circuits that are located in the upper left corner of the circuit board.

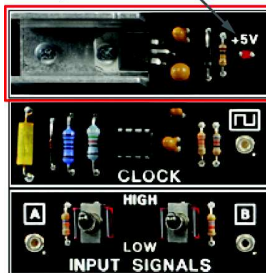


The support circuit blocks include:

POWER SUPPLY

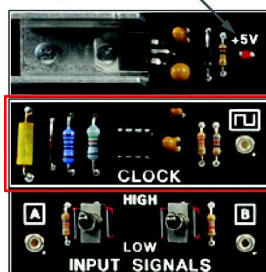
REGULATOR (not labeled),

LED for 5 Vdc
voltage indication



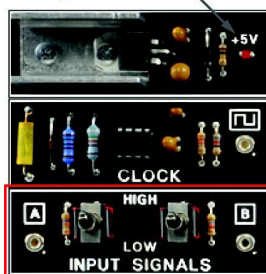
CLOCK,

LED for 5 Vdc
voltage indication



and INPUT SIGNALS.

LED for 5 Vdc
voltage indication



The ten circuit blocks that contain digital logic circuits are:

- AND/NAND circuit block
- OR/NOR circuit block
- XOR/XNOR circuit block
- OPEN COLLECTOR circuit block
- SET/RESET FLIP-FLOP circuit block
- D-TYPE FLIP-FLOP circuit block
- JK FLIP-FLOP circuit block
- TRI-STATE OUTPUT circuit block
- TTL/CMOS COMPARISON circuit block
- DATA BUS CONTROL circuit block.

The ten digital logic circuit blocks are organized into the following lessons:

- Fundamental Logic Elements
- Exclusive OR and NOR Logic Functions
- Open Collector and Other TTL Gates
- Flip-Flops
- JK Flip-Flops
- Tri-State Output
- TTL and CMOS Comparison
- Data Bus Control
- Troubleshooting.

The definition and operation of each digital logic circuit are presented in the above lessons.

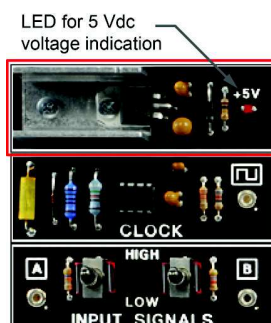
The INPUT SIGNALS and CLOCK circuit blocks

- a. demonstrate the functions of OR and NOR gates.
- b. provide static high and low signals and a dynamic square wave signal to the circuit blocks.

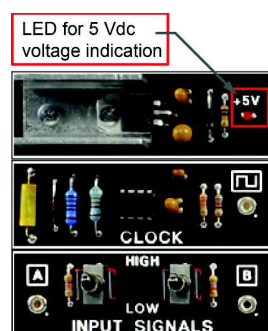
Power Supply Regulation

The POWER SUPPLY REGULATOR circuit block, which is not labeled, is located above the CLOCK circuit block.

The power supply regulator converts the 15 Vdc supply to the base unit to a regulated 5 Vdc supply for the circuit board.

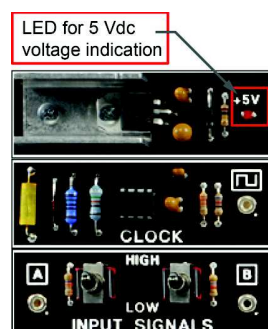


When the red LED on the right side of the circuit block is on (glowing), there is a 5 Vdc supply to the circuit blocks.



Be sure that the power supply regulator LED is always on when you do the exercise procedures.

All the circuit blocks use a 5 Vdc supply. The TTL/CMOS COMPARISON circuit block also uses a 15 Vdc supply directly from the base unit.

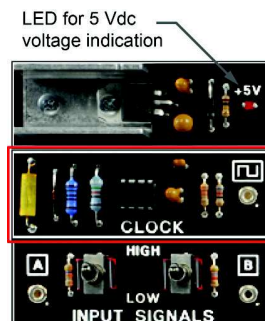


When the red LED is on (glowing) in the POWER SUPPLY REGULATOR circuit block,

- a. 10 Vdc power is supplied to the circuits.
- b. 5 Vdc power is supplied to the circuits.

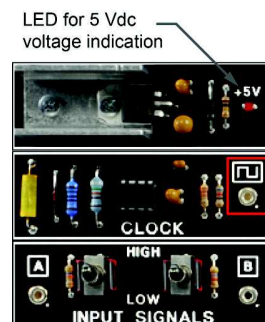
Clock

The CLOCK circuit block provides a square wave, 50 kHz pulse train signal with a $5\text{ V}_{\text{pk-pk}}$ amplitude.



The output of the CLOCK is labeled with a square wave symbol.

The clock signal is used by several circuit blocks as a dynamic input signal.

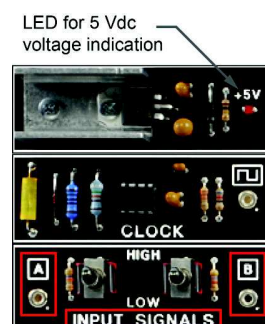


The CLOCK output terminal is labeled

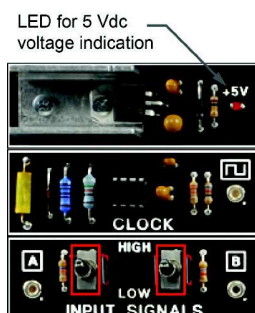
- with a square wave symbol.
- A and B.

Input Signals

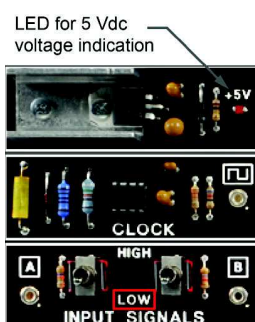
The INPUT SIGNALS circuit block has two outputs labeled A and B.



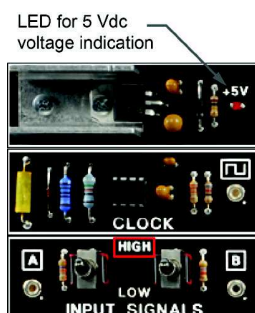
There is a toggle switch for each output.



When the toggle switch is in the LOW position, the output is at a logic 0, or low level (0 Vdc).

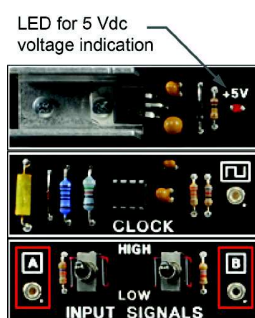


When the toggle switch is in the HIGH position, the output is at a logic 1, or high level (5 Vdc).



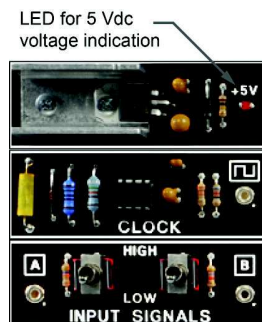
Outputs A and B of the INPUT SIGNALS circuit block are connected to inputs A and B of the circuit blocks during the procedural steps to provide either a logic 0 (0 Vdc) or a logic 1 (5 Vdc) input signal.

Test leads (interconnecting leads) are used to make the connections.



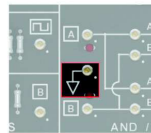
When toggle switches A and B are in the HIGH position, the signal at the A and B terminals is

- logic 1 (5 Vdc).
- logic 0 (0 Vdc).



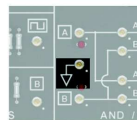
Ground Terminals

Ground terminals on the circuit board are labeled with a ground symbol.



Ground terminals (0 Vdc) are located in several of the circuit blocks.

When using the multimeter or oscilloscope, be sure to connect the black common lead to a ground terminal on the circuit board.

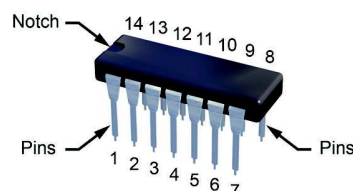


The common lead of a multimeter or an oscilloscope should always be connected to

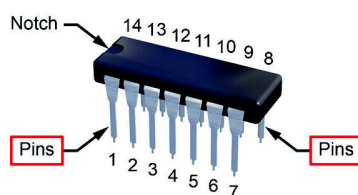
- the B terminal of the INPUT SIGNALS circuit block.
- one of the ground terminals on the circuit block.

Integrated Circuit Packages

The digital logic circuits on the circuit board are contained in dual-in-line package (DIP) integrated circuit (IC) packages.

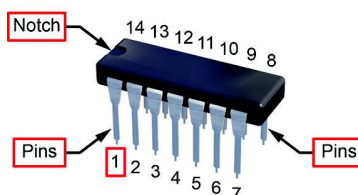


Dual-in-line package (DIP) means that the pins are positioned in a line on both sides of the IC package.



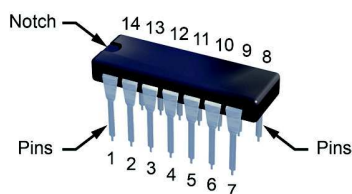
From the top side of the IC, pin 1 is located to the left of the notch, as shown below. The pins are numbered counterclockwise.

These IC packages usually contain several logic circuits of the same type.



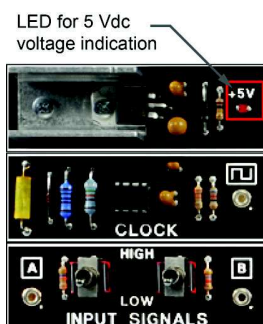
For an integrated circuit (IC), DIP means

- a. digital integrated pulse.
- b. dual-in-line package.

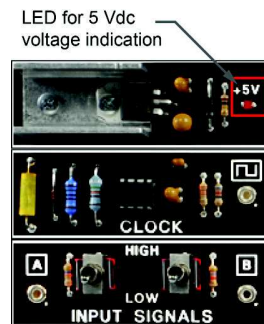


PROCEDURE

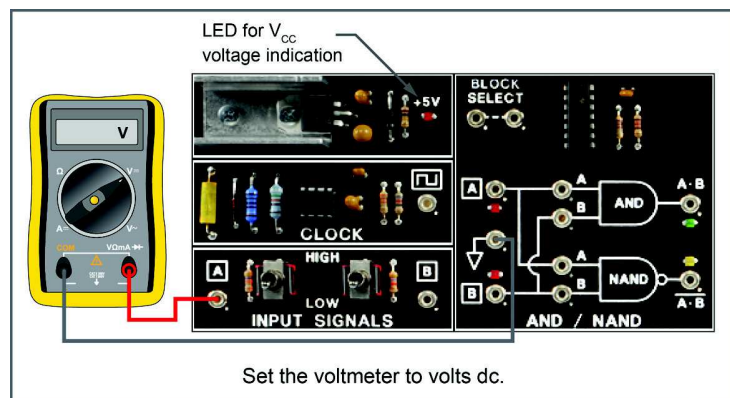
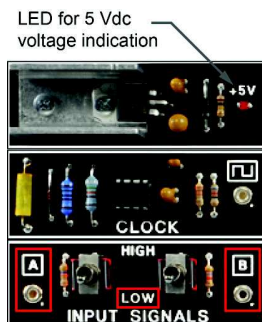
1. In the POWER SUPPLY REGULATOR circuit block (upper left corner of the circuit board), is the LED on (glowing)?
 - a. yes
 - b. no



- 2. When the POWER SUPPLY REGULATOR circuit block LED is on, the 15 Vdc supply to the base unit is
- not being regulated to 5 Vdc.
 - being regulated to a 5 Vdc supply for the circuit board.
 - being supplied to the circuit board.

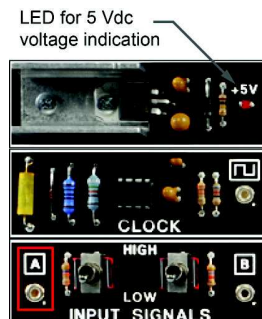


- 3. In the INPUT SIGNALS circuit block, set toggle switches A and B to the LOW position.

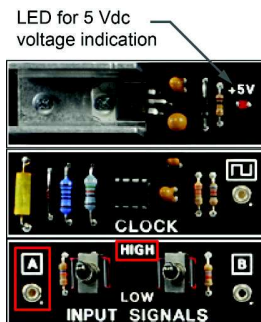


Connect the red (positive) lead of a voltmeter to the A terminal, and connect the black (negative) common lead to a ground terminal on the circuit board. The logic state of the A terminal is

- logic 0, or low (0 Vdc).
- logic 1, or high (5 Vdc).



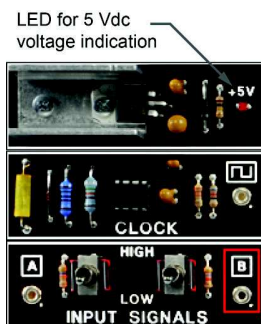
- 4. Change the position of toggle switch A to HIGH. The logic state of the A terminal is
- logic 0, or low (0 Vdc).
 - logic 1, or high (5 Vdc).



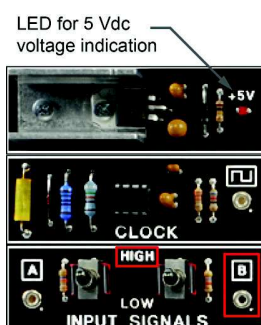
- 5. Connect the red (positive) lead of a voltmeter to the B terminal. Leave the black (negative) common lead connected to the ground.

The logic state of the B terminal is

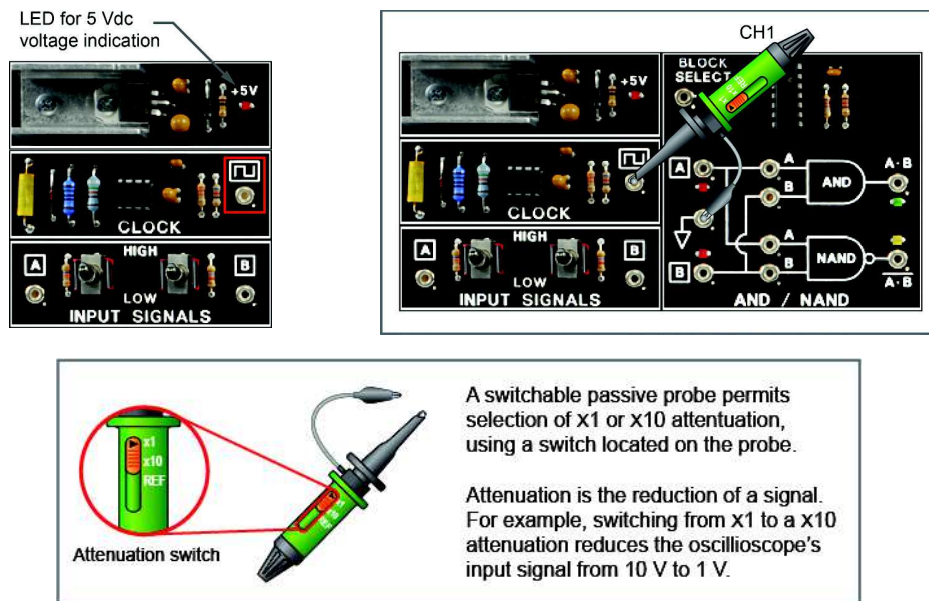
- logic 0, or low (0 Vdc).
- logic 1, or high (5 Vdc).



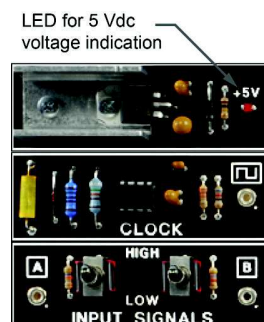
- 6. Change the position of toggle switch B to HIGH. The logic state of the B terminal is
- logic 0, or low (0 Vdc).
 - logic 1, or high (5 Vdc).



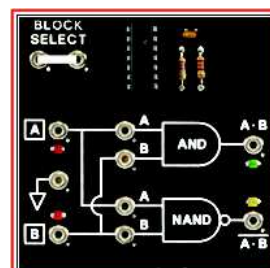
- 7. Connect the channel 1 probe of the oscilloscope to the output terminal at the CLOCK circuit block. Connect the channel 1 probe ground clip to a ground terminal on the circuit board.



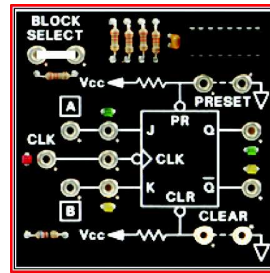
- 8. Set the channel 1 probe to X10, and set the channel 1 vertical sensitivity to 0.5 V/div. With these settings, each vertical division (Y-axis) on the oscilloscope screen is 5 V/div.
- Set the sweep to 5 μ s/div and trigger on channel 1. With this setting, each horizontal division is 5 μ s/div.



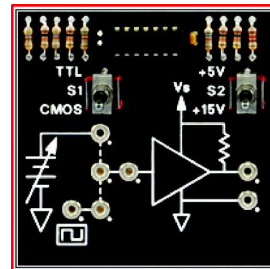
- 9. The signal on channel 1 of the oscilloscope is a
- sine wave with a 5 V_{pk-pk} amplitude and a frequency of 50 kHz.
 - square wave with a 5 V_{pk-pk} amplitude and a frequency of 50 kHz.
- 10. The circuit shown is the
- AND/NAND circuit block.
 - OR/NOR circuit block.
 - XOR/XNOR circuit block.



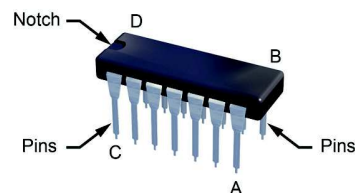
- 11. This circuit is the
- OPEN COLLECTOR circuit block.
 - D-TYPE FLIP-FLOP circuit block.
 - JK FLIP-FLOP circuit block.
 - SET/RESET FLIP-FLOP circuit block.



- 12. This circuit is the
- TRI-STATE OUTPUT circuit block.
 - TTL/CMOS COMPARISON circuit block.
 - DATA BUS CONTROL circuit block.



- 13. Pin 1 of the IC shown here is located at
- A.
 - B.
 - C.
 - D.



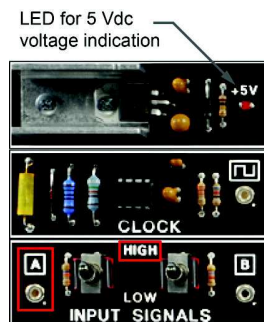
CONCLUSION

- The DIGITAL LOGIC FUNDAMENTALS circuit board contains 13 circuit blocks.
- The POWER SUPPLY REGULATOR, CLOCK, and INPUT SIGNALS circuit blocks are support circuits to the ten circuit blocks that contain digital logic circuits.
- The +5 V LED indicates that 5 Vdc power is available to the circuit board.
- The CLOCK circuit block provides a 50 kHz square wave clock signal.
- The INPUT SIGNALS circuit block provides two outputs (A and B) for static high (logic 1) and low (logic 0) signals.
- The circuit board contains several ground terminals.
- The logic circuits on the circuit board are contained in dual-in-line (DIP) integrated circuit (IC) packages.

REVIEW QUESTIONS

1. Before doing the exercise procedures, what is the first thing that you should check on the DIGITAL LOGIC FUNDAMENTALS circuit board to be sure that the circuits will work properly?
 - a. Check that the 15 Vdc power supply is turned on.
 - b. Check that toggle switches A and B are in the LOW position.
 - c. Check that the +5 V LED is on (glowing).
 - d. Check that the CM and fault switches are off.
2. Static logic 1 (high) and logic 0 (low) signals are obtained from the
 - a. CLOCK circuit block.
 - b. DATA BUS CONTROL circuit block.
 - c. 15 Vdc power supply.
 - d. INPUT SIGNALS circuit block.

3. If toggle switch A on the INPUT SIGNALS circuit block is set to the HIGH position, the signal at the A output is
 - a. logic 0.
 - b. in a high-Z state.
 - c. logic 1.
 - d. a 50 kHz square wave.



4. When using an oscilloscope to observe a signal, connect the oscilloscope probe ground (common) clip to
 - a. the output terminal on the CLOCK circuit block.
 - b. one of the ground terminals on the circuit board.
 - c. the B output terminal on the INPUT SIGNALS circuit block.
 - d. a terminal with a 5 Vdc output.
5. The DIGITAL LOGIC FUNDAMENTALS circuit board contains how many circuit blocks that have logic circuits?
 - a. 10
 - b. 13
 - c. 12
 - d. 11